cannot be kept alive as long as when defibrinated dog's blood is employed; (4) that no matter how long an experiment lasts the defibrinated blood, circulated again and again through heart and lungs, shows no tendency to clot; hence fibrinogen is not produced in those organs.

The question answered by the first of the above results was the one for whose solution the research was undertaken. The experiments show that, in spite of its highly developed extrinsic nervous apparatuses, the heart of the mammal does, so far as its rhythm is concerned, in its own nervo-muscular tissues, respond to temperature variations within wide limits (42°—27° C.), just as the frog's heart or that of the embryo chick does. To account for the quick pulse of fever we, therefore, need not look beyond the mammalian heart itself; we require no theoretical assumption of any paralysis of inhibitory, or any excitation of accelerator cardio-extrinsic nerve-centres.

*January* 18, 1883.

THE PRESIDENT in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

## I. "Preliminary Paper on a Uniform Rotation Machine; and on the Theory of Electromagnetic Tuning Forks." By R. H. M. BOSANQUET, St. John's College, Oxford. Communicated by Professor H. J. S. SMITH, F.R.S. Received December 20, 1882.

(Abstract.)

The primary object of the machine is the construction of standard notes. It admits also of the accurate determination of tuning forks, &c., having pitch near that of any standard note of the machine, besides other applications.

The machine consists of a three-crank axle with a fly-wheel. The cranks are acted on by electro-pneumatic levers, the valves of which control the wind supply as the slide-valve of a steam engine does the steam. Two of these are acted on by a commutator on the axis; the third is connected with a clock which closes the circuit at every second. The effect of this is to govern the machine, so that it will

revolve once per second under wide variations of the driving power. The fly-wheel originally consisted of, and now carries, brass disks two feet in diameter, having various numbers of slits cut in them spokewise. Those disks which have been made represent pitches of tenor C, covering the whole range in practical or theoretical use.

Tuning forks having any multiple or submultiple of the frequency of the disk employed, present, when examined against an illuminated background behind the disk, toothed patterns which remain stationary. If the fork is a little sharp the pattern moves in the opposite direction to the slits, if flat in the same direction. When the machine oscillates about its mean velocity, a fork in tune with the machine presents a pattern which swings backwards and forwards.

While the machine was yet in an early and imperfect state, it was demonstrated that large tuning forks, when excited electrically with a mercury contact, vary their frequency by change of level of the mercury, within limits which may readily amount to 1 in 200.

A device due to Lord Rayleigh was employed with the object of extinguishing the oscillations. A ring of metal tubing was filled with water, and mounted as a rim on the disk. But this had practically no effect. An extensive series of experiments was then undertaken, in which large quantities of tubing filled with water were employed. Some slight effect was ultimately obtained, but nothing useful. The end desired was attained with mercury in india-rubber tubes. The damping does not as yet amount to a dead beat action, and it is hoped that it may be improved. The damping at present obtainable under practical conditions is reduction of swing to $\frac{1}{2}$ in $10^s$.

With the machine thus improved, observations have been made of the variations of pitch of a middle C fork, with an electric spring contact, under varying tension. The changes which occur appear to be less than in the case of the mercury contact.

The experiments that have been made on electromagnetic tuning forks lead to an outline of the theory of the motion in this case, which appears to depend on the time of magnetization of the magnetic system. Although studies have been made on this subject, there is nothing in the shape of a theory depending on absolute measure for guidance in arranging and interpreting experiments. Such a theory is here outlined, and compared with experiment.

The theory depends on the assumption that the systems dealt with are closed magnetic circuits with small breaks, or cores of solenoids not projecting far from the coils. Under certain limitations the resistance of the magnetized iron can be neglected in comparison with that of the air spaces traversed, according to the values of the permeability of iron furnished by Rowland's experiments.

The permeability of the system is then deduced from the comparison of resistances in the air space of the core of the solenoid, and in the air spaces which form the breaks in the magnetic circuit.

The coefficient of electromagnetic momentum is then, by means of known equivalents, expressed in terms of the permeability of the system, and thence, according to the above result, in terms of the configuration of the breaks in the magnetic circuit.

A method is then developed of calculating the coefficient of electromagnetic momentum from the observed mean current during the excitation of a tuning fork of known period.

Four experiments of this description were made, and the value of the terms depending on the configuration of the air spaces analysed and interpreted in connexion with the numerical results thus obtained.

In this manner I was led to distinguish two theoretical cases which were connected by an empirical configuration formula, bridging over the gap between them. The experiments in question agree with the configuration formula to a degree far beyond what could have been anticipated, considering the roughness of the methods employed for the determination of the several elements concerned.

The result is, that in a certain class of electromagnetic systems, when the configuration is given, the permeability and coefficient of electromagnetic momentum can be approximately assigned, and the whole electromagnetic behaviour of the system approximately calculated.

With this theory at my disposal I hope to make further contributions to the knowledge of electromagnetic tuning forks.

## II. "On the Skeleton of the Marsipobranch Fishes. Part II. The Lamprey." By W. K. Parker, F.R.S. Received January 10, 1883.

(Abstract.)

In working out this type I have been greatly indebted to the labours of J. Müller, Huxley, Schneider, Balfour, and Scott.

For *materials* I am indebted to two of the above-mentioned anatomists, namely, Professor Huxley and the late Professor Balfour, also to Surgeon-Major Francis Day, of Cheltenham, and Osbert Salvin, Esq., F.R.S.

The transformed skeleton is described in various young individuals of the Sea Lamprey (*Petromyzon marinus*), from four to eight or nine inches in length. The smallest of these was scarcely through its metamorphosis. A specimen of *P. planesi* was worked out at the same